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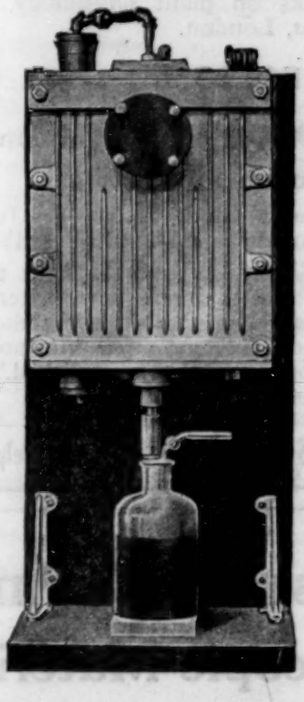

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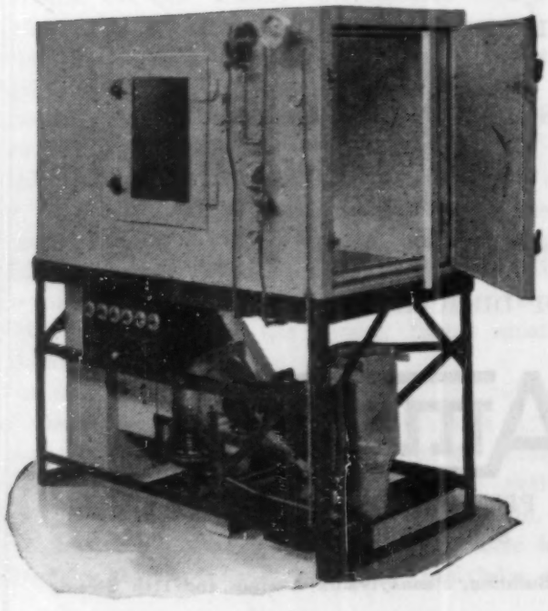

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LIGHT WAVES IN ASTRONOMY[1]

WHEN any object is viewed in a telescope the image formed at the focus results from the concurrence of the light waves which reach the focus from all parts of the object glass.

In the simplest case—that of a star which is so far away that it may be regarded as a point of light the image will not be a point, but a disc of appreciable size surrounded by a series of concentric circles as shown in Figure 1*a*.

In the case of a double star each component will present such a figure readily separable in a telescope of adequate size as in Figure 1*b*.

But if the stars form a very close double, the two figures overlap as in Figure 1*c* and in this case the system is not to be distinguished as a double.[2]

It can readily be shown that the limit of resolution is reached when the relation between the angular separative α_0 is given when this is equal to the ratio of the length λ of the light wave to the diameter d of the objective multiplied by the constant factor 1.22.

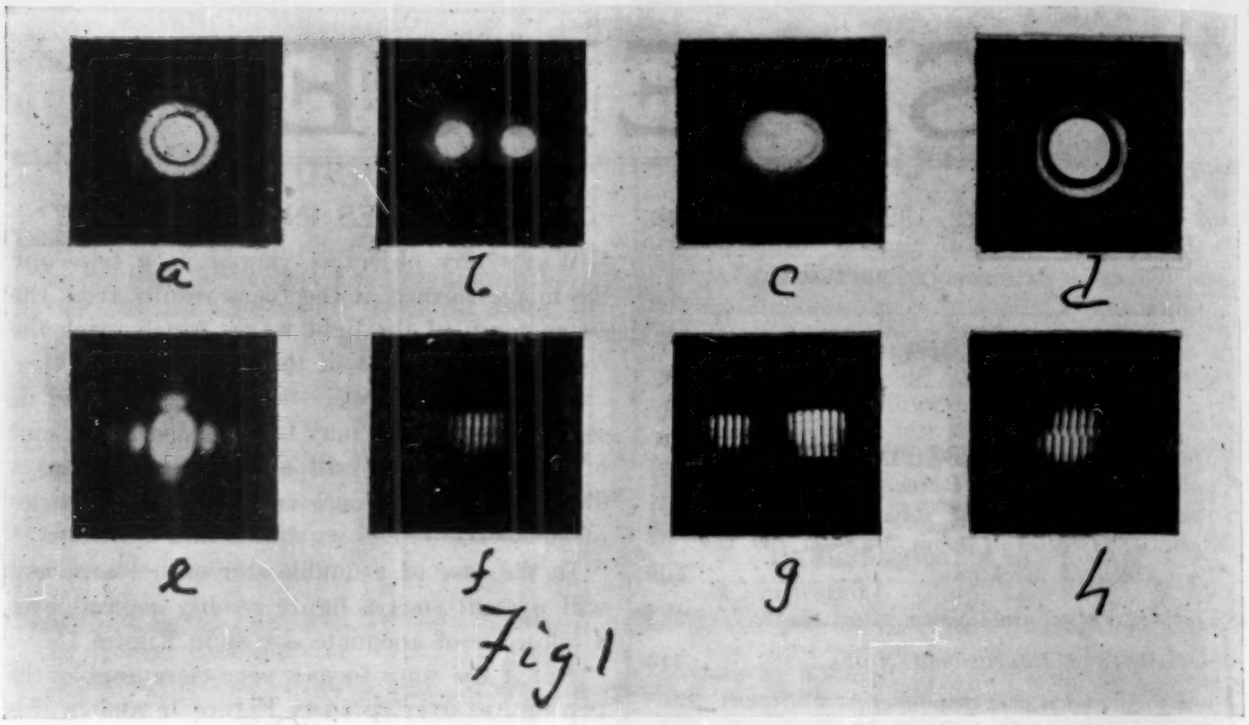
Thus in case of the 100-inch telescope at Mt. Wilson the angle would be $1.22 \times 1/50000$ x 1/100 or one in four million, corresponding to an angle of about one twentieth of a second of arc; which may be visualized as the appearance of a dime thirty miles away.

Next consider the appearance of an object presenting an actual disc such as a small planetoid. Each point of the disc would form an image like that in Figure 1*a*, the integrated effect corresponding to the appearance in Figure 1*d*.

Here again the appearance of d will not be distinguishable from Figure 1*a* if the angular diameter of the disc is less than $\alpha_0 = 1.22\lambda/d$. This then corresponds to the utmost attainable

[1] Abstract of a lecture given under the auspices of the Carnegie Institution of Washington on April 26, 1923.

[2] At least not accurately measurable though there may be indications of doubling.



limit of resolution with the largest telescope in the world under perfect conditions of atmosphere.

But the character of the image at the focus (taking for simplicity the case of a star) depends on the form of the aperture of the telescope. If this were square instead of round the appearance would be that represented in Figure 1*e*.

If instead of a single aperture there are two arranged as in Figure 2 the appearance of the

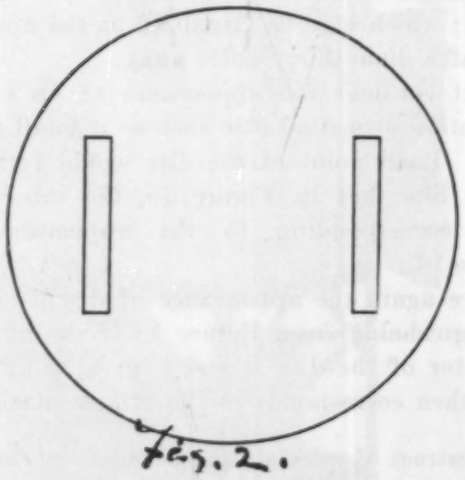
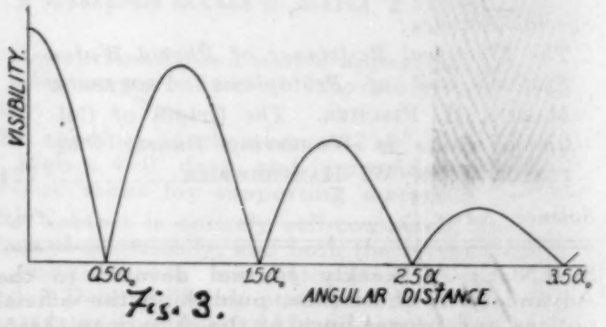


image of a star would be that shown in Figure 1*f*.

The figure presents no resemblance in this case to the object, but for purposes of measurement it has two important advantages. These may be best illustrated by considering once more the case of a double star, which would show a diffraction figure corresponding to Figure 1*g* if the two stars were well separated. If, however, the stars form a close doublet, these two figures will overlap[3] and at a definite distance will entirely vanish, if the two stars are equally bright. The graph representing the visibility of the fringes as a function of the distance between the two apertures is shown in Figure 3 corresponding to the formula



$V = A\cos\pi\alpha/\alpha_0$ ($\alpha_0 = \lambda/d$). The vanishing of the fringes (which may be observed with remarkable accuracy) occurs at intervals corres-

[3] Fig. 1h represents the diffraction figure due to a very close doublet, the components of which are not in the same horizontal plane. If they were in the same plane, the fringes would vanish.

ponding to $\alpha = 1/2\alpha_0$, $3/2\alpha_0$, etc., or when

$$\alpha = \frac{\lambda}{2d}, \frac{3\lambda}{2d}, \text{ etc.},$$

so that the resolution of a doublet by this method can be clearly established with a telescope of only four tenths the diameter of that required when using the full aperture.

But much more important is the fact that the vanishing of the fringes (or even the observation of the minimum in case the stars are of unequal brightness) is capable of far greater accuracy than the more or less vague observation of "resolution." Similar considerations show that the curve, Figure 4, representing the graph of the formula

$$\gamma = \int_0' \sqrt{1 - w^2} \cos nw \, dw$$

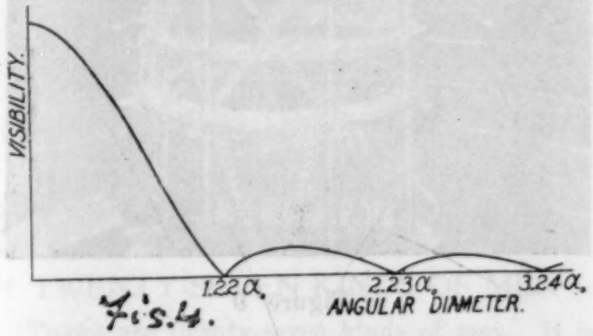


Fig. 4.

where $n = \pi d\alpha/\lambda$ give values $\alpha = 1.22\frac{\lambda}{d}$, $2.44\frac{\lambda}{d}$, etc., for the points at which the fringes vanish; whence α, the angular diameter of the disc, may be found—and with an order of accuracy but little inferior to that found in the measurement of the angular distance between the components of a double star.

A test, by the interference method, of the measurement of the diameter of the Satellites of Jupiter was made at Mt. Hamilton in 1890, giving results of considerably greater accuracy than any hitherto obtained, and proving clearly the applicability of the method to the measurement of discs of much smaller angular diameters than these. Thirty years afterward, by invitation of Dr. Geo. E. Hale, it was proposed to make an extended investigation into the possibilities of the method at the Mt. Wilson Observatory.

A preliminary trial with the forty-inch at the Yerkes Observatory showed clearly that interference fringes were readily observed even when atmospheric disturbances made "seeing" too poor for the usual astronomical observations. The same result[4] was obtained with the 60-inch and finally with the 100-inch at Mt. Wilson.[5]

The feasibility of the interference method being thoroughly confirmed, the problem of the investigation of the angular distance between the components of a double star was undertaken by Dr. J. A. Anderson.

From spectroscopic evidence Dr. W. W. Campbell showed that the star Capella was a binary star whose angular separation was just beyond the separating power of the 100-inch, so that it presented an object most suitable for the test.

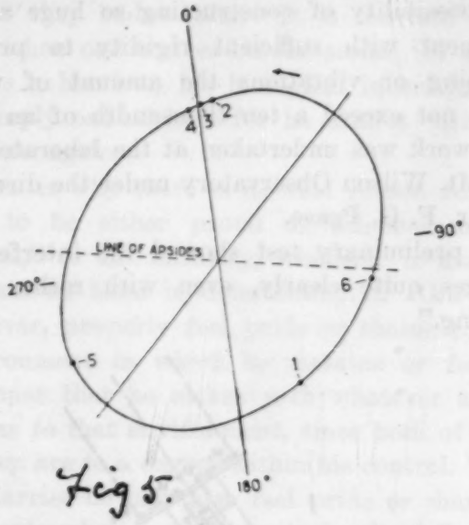


Fig 5.

The results of Dr. Anderson's work are shown in the graph, Figure 5, representing the orbit. The results of a comparison of the separate observations with the calculated orbit show that the accuracy of these measurements reach the extraordinary limit of one ten thousandth of a second of arc. (A dime at 30 miles distant would show corresponding irregularities of the

[4] In this last test a diaphragm with two small apertures was placed near the focus, instead of at the objective, making measurement much more conveniently and without any loss of accuracy.

[5] A probable explanation of this unexpected result is doubtless something like the following:

When the entire aperture of the telescope is used, the integrated effect of the atmospheric disturbances is a confusion of the focal image generally referred to as "boiling." In the case of two small apertures at opposite ends of a diameter, the fringe system moves as a whole, but is nevertheless quite distinct so long as the motion is not too rapid for the eye to follow.

order of a thousandth of an inch.) The stars are so far distant that, although many of them are much larger than our sun, the angular diameter of the disc they would present is too small for the largest telescope to discern. It would require a telescope two or three times as large as the 100-inch instrument at Mt. Wilson to render visible even the largest of these. The interferometer, however, offers a base line which may be much larger than the diameter of the telescope; and the previous work justified the hope that atmospheric disturbances would not seriously affect the clearness of the interference fringes.

There was, however, considerable doubt as to the possibility of constructing so huge an instrument with sufficient rigidity to prevent warping or vibrations the amount of which must not exceed a ten thousandth of an inch. The work was undertaken at the laboratory of the Mt. Wilson Observatory under the direction of Mr. F. G. Pease.

A preliminary test showed the interference fringes quite clearly, even with rather poor "seeing."

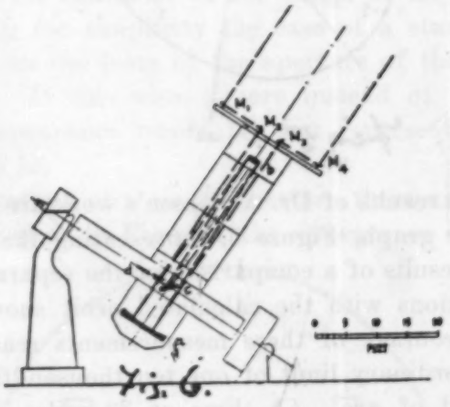
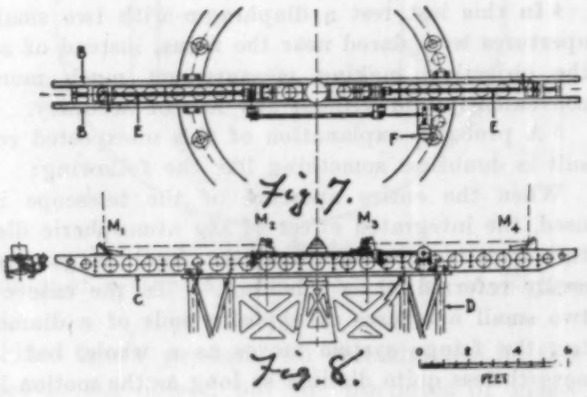


Fig. 6 gives a schematic view of the arrangement.



M, M_4 are two plane mirrors which reflect light from the star to the two mirrors M_2M_3, whence they proceed to the concave reflector M_5, proceeding thence ultimately to the focus of the instrument where they produce interference bands, which are viewed by an eyepiece at E.

Figure 7 shows the plan and Figure 8 the elevation of the interferometer beam and Figure 9 is a photograph of the beam attached to the tube of the telescope.[6]

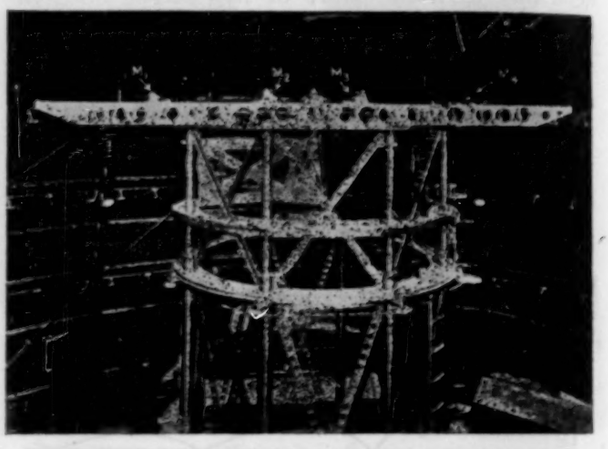


Figure 9

On December 13, 1920, Mr. Pease reported: "After preliminary settings on β Persei, with the mirrors separated 81 inches; and on β Persei and γ Orionis, with a separation of 121 inches (thus insuring that the instrument was in perfect adjustment), it was turned on α Orionis (Betelgeuse) and the interference fringes were sought for some time but could not be found. When next turned on α Canis Majoris the fringes at once appeared, thus furnishing a complete check."

The expression of the relation between α, the angular diameter of the star, and the distance δ between the mirrors at disappearance is $\alpha = 1.22\lambda/d$. Assuming the effective wave length $\lambda = 5750$ Angstrom units, and $d = 300$ c.m. the anguar diameter of Betelgeuse is 0".047. To find the actual diameter of the star we must multiply this by the distance of the

[6] It was not at all necessary for optical requirements to use so large a telescope; but the 100-inch had such great stability that the additional weight (some 800 pounds) produced no derangement of its adjustments.

star, which in terms of its parallax 0".018 gives a result

$$\frac{.047}{.018} \times 92{,}500{,}000,$$

that is a diameter of 240 million miles, 300 times the diameter of our sun!

This value is based, however, on the assumption that the disc presents a uniform illumination; but as there is undoubtedly a falling off of intensity away from the center this result may be considerably too small.

Since the announcement of this result several other stars have shown an appreciable diameter and one, Antares, is found to be even a bigger giant than Betelgeuse.

A still larger interferometer with a base of fifty feet is now under construction, by means of which the number of stars which fall within range will be considerably increased and it may even be hoped that the distribution of light over the discs may be determined.

A. A. MICHELSON

UNIVERSITY OF CHICAGO

TWENTY-SEVEN KINDS OF MEN

THERE are twenty-seven kinds of men. It is worth while to take account of personal stock and to honestly decide which of the twenty-seven varieties we ourselves represent, for it may be possible, within limits, to change ourselves, if desirable, into different sorts of men.

Or better yet, we might try to classify our neighbor whose faults, if not his virtues, are usually more apparent than our own. It is always an engaging mental exercise to size up other people since success in life depends largely upon correct judgments concerning those with whom we have to deal. In order to do this fairly we must discover what determines the sort of person our neighbor is and wherein he or she differs from twenty-six other kinds of people. There are three contributing factors that go to make up any man—or woman—and no one of the three can possibly be omitted.

The first is *environment* or the surroundings in which a person is brought up. It represents the opportunity or chance in life which one has. The second is *natural capacity* which is inherited from one's forbears. This is heredity or endowment. The third factor is the *response* which is made with a given inheritance, whatever it may be, within one's particular surroundings.

Environment is the stage setting; inheritance the actor and the response what the actor performs upon the stage. The play involves all three. Environment is what a man *has;* inheritance is what he *is* and response is what he *does*. It takes all three of these things to make a neighbor or any one else.

Furthermore, inheritance is decided beforehand for every man. No one can choose his parents or determine the inborn capacity with which they endow him. It is too late to do that when one arrives on the scene. If a man draws a blank in his biological inheritance he is simply out of luck for he cannot change it or draw again.

This is why there is no real reason for any one to be either proud or ashamed of his "blood," or his ancestry, whatever it may be. He has no hand in determining it. One may, however, properly feel pride or shame for the environment in which he remains or for the response that he makes with whatever ability he has to that environment, since both of these factors are to a degree within his control. When he marries he may also feel pride or shame in the mate whom he chooses to be the fellow determiner of the natural capacity which he wills to his children, because it is within his control thus to enrich or cheapen the blood that he has to pass on to the next generation.

To reduce the matter to the simplest terms, the three fateful factors that determine a man, namely, environment, heredity and response, may each occur in at least three varying grades indicated roughly as good, medium and poor. By combining these factors we arrive at twenty-seven kinds of men. For example, the inheritance that a man is born with may be good, medium or poor. Likewise the environment in which he finds himself and the response that he makes under the circumstances may be also good, medium or poor. In the list below are given the twenty-seven possible combinations resulting from this simple arrangement:

	Inheritance	*Environment*	*Response*
1.	Good	Good	Good
2.	Good	Good	Medium
3.	Good	Good	Poor
4.	Good	Medium	Good
5.	Good	Medium	Medium
6.	Good	Medium	Poor
7.	Good	Poor	Good
8.	Good	Poor	Medium
9.	Good	Poor	Poor
10.	Medium	Good	Good
11.	Medium	Good	Medium
12.	Medium	Good	Poor
13.	Medium	Medium	Good
14.	Medium	Medium	Medium
15.	Medium	Medium	Poor
16.	Medium	Poor	Good
17.	Medium	Poor	Medium
18.	Medium	Poor	Poor
19.	Poor	Good	Good
20.	Poor	Good	Medium
21.	Poor	Good	Poor
22.	Poor	Medium	Good
23.	Poor	Medium	Medium
24.	Poor	Medium	Poor
25.	Poor	Poor	Good
26.	Poor	Poor	Medium
27.	Poor	Poor	Poor

We are now ready to classify our neighbor. Which of the twenty-seven possible types does he represent and what hope is there of transforming him into a better man?

Take the case of a man like number fourteen in the list who is "medium" in all of the three determining particulars. How can he shift his position in the scale of life and become a different man?

In the first place he *can not change his heredity,* for, unlike the heir who inherits material property, he can neither lose nor add to his heritage of innate capacity, any more than a rabbit can lose or add to what makes it a rabbit and become a bird or some other animal. A man born medium in capacity must remain so.

He *can modify the environment* which holds him in its influential embrace and he *can* also *change his response* to that environment, either through education, experience and effort, or by the neglect of these means, so that the result will be a different kind of a man.

Moreover it is plain that in selecting a mate for our neighbor, which is always less complicated than selecting a mate for one's self, number nine in the list, that is, a person with good inheritance, poor environment and poor response, would be a better risk for him than number nineteen for instance, which denotes a person with poor inheritance, good environment and good response, not only because there would be more hope of improvment during the lifetime of the prospective partner but also because the possible children of such a union would start life with better "blood" or capacity and that is a priceless thing.

Too frequently what passes for a "good match" in society refers solely to environment and material possessions of the parties concerned rather than to their biological inheritance or blood. A man may marry a fortune and lose it but he can not lose his mother-in-law and all she means to the blood of his children. It is far better, indeed, to marry good blood than good environment because natural capacity usually leads, sooner or later, to an effective response which is likely in the end to insure a desirable environment. The self-made man who feels commendable pride in his handiwork is one who has risen in the ranks of the twenty-seven kinds of men but no one, even in a democracy, can go all the way from the bottom of the ladder to the top in one lifetime. That accomplishment takes generations of time and a judicious selection of one's grandparents.

H. E. WALTER

BROWN UNIVERSITY

SCIENTIFIC EVENTS

THE ROCKEFELLER BUILDINGS AT UNIVERSITY COLLEGE, LONDON

A VISIT of the King and Queen of England to University College and its Medical School, London, to lay the foundation stones of the new obstetrical hospital and the new nurses' home was paid on May 31. According to the *British Medical Journal* these two buildings are in Huntley street, whose northern end is already occupied by one side of the medical school buildings which front the side of the hospital in University street. The King and Queen also formally opened the new Anatomy Institute of University College, recently erected in Gower street immediately south of the college quadrangle and west of the Physiological Institute, which also has been enlarged. It was announced nearly two years ago that the Rockefeller Foundation had arranged to give sums amounting together to £1,205,000 to University College and University College Medical School with the aim

of forming in London an ideal medical school equipped in all departments on the most modern lines. Of the total amount given to the college the sum of £370,000 was for an Institute of Anatomy and for additions to the staff of that department and certain others. The cost of the site, building, equipment and library of the Institute of Anatomy was estimated to be £190,000, leaving a capital sum for maintenance of £180,000, calculated to provide £5,000 a year for additional staff in the anatomy department, £2,500 in the physiology department and £1,500 in other departments. University College Hospital fills an island site, so that it is not susceptible of enlargement. The number of beds at the disposal of the directors of the clinical units recently established was considered to be too small and it was not found possible to make proper provision for obstetrics. It was decided, therefore, to take over the space in the nurses' wing and to build a new nurses' home and a new obstetrical hospital. The Rockefeller Foundation arranged to give £400,000 to University College Hospital and Medical School for building and reconstruction and £435,000 for maintenance. The income of this endowment fund is to be used for the furtherance of medical education and research in the Medical School, but a sum not exceeding £16,000 a year is to be applied to the upkeep of the 120 beds allocated to the purposes of the medical and surgical units until such time as money can be otherwise raised, when the income of the endowment will be restored to its original purpose of helping medical education and research. The new buildings for the obstetrical department, it is estimated, will cost £110,000 and will provide sixty beds; the responsibility for their maintenance will fall on the corporation of the hospital, which will have to increase its present income by some £15,000 to £20,000 a year.

"UNIVERSITY CITY" AT PARIS

THE Paris correspondent of the *Journal* of the American Medical Association reports that the corner stone of the "University City" was laid on May 9 in the presence of M. Léon Bérard, minister of public instruction; M. Paul Strauss, minister of public health; Professor Paul Appell, rector of the University of Paris; the deans of all the faculties of the University of Paris; Dr. de Lobinière-Harwood, dean of the Faculty of Medicine of Montreal; Dr. Rousseau, dean of the Faculty of Medicine of Quebec, and many other university professors. The men and the women students were represented by the respective presidents of the general associations. A student, M. Kauck, read an account of the origin of the University City, which had been engrossed on parchment and which was afterward enclosed in the corner stone of the edifice, together with a number of coins of this year's mintage, to perpetuate the memory of the establishment.

This is the first of a group of buildings intended to provide healthy and economical lodgings for 350 men and women students of limited means. They are to be erected on the leveled fortifications of Paris, at the southern extremity of the Latin Quarter, on a plot of ground deeded by the city to the University of Paris. The funds for the buildings themselves were secured through the liberality of M. Emile Deutsch de la Meurthe, who made for this purpose a gift of ten million francs. The hope is entertained that the foundation established by M. Deutsch de la Meurthe will be followed by others, all destined to provide for the needs of students and due to the initiative of generous minded persons, whether they be French or foreigners, who are friends of France. This group of buildings will form the University City, so called, and will constitute a suburb for students situated between the Montsouris Park and another park to be especially laid out for them through the solicitude of the city of Paris. As is impressively stated in the parchment roll deposited in the corner stone, "Thus will have been established a new focus of French and human culture, where three thousand students, coming from all countries of the world, provided with books, sunlight and fresh air, brought together in affectionate emulation and reflecting honor on the oldest university of Europe (founded in the second half of the twelfth century), will work together in concert to bring about a harmonious development of their minds and bodies, which will redound to the progress of science and to an understanding among the nations they represent."

AWARDS OF THE ROYAL GEOGRAPHICAL SOCIETY

LORD RONALDSHAY made the presidential address at the anniversary general meeting of the Royal Geographical Society on May 28. At its conclusion he presented the medals and announced the other awards for the year:

The Founders' Medal—the highest recognition of the society—he said, was awarded this year to a distinguished Danish explorer, Mr. Knud Rasmussen, for his scientific exploration of Greenland and the American Archipelago, which he had been carrying on with unabated zeal and with marked success over a period of more than twenty years. The son of a Danish missionary in North Greenland, Mr. Rasmussen included amongst his achievements the famous journey in 1912 across the inland ice of North-West Greenland to the opposite coast and back, one result of which was to show that Peary Land was a part of the mainland, the supposed Peary Channel being a fjord only. A further journey, planned in 1916 and undertaken in 1917, with an investigation of possible Eskimo migrations by the extreme north of Greenland as one of its objects, produced no trace of any such migration. This negative result, however, was accompanied by positive results of value in the spheres of botany, zoology and geology, thanks to the labors of his companions, Wulff and Koch, while all the great fjords along the north of the coast of Greenland were mapped. The expedition was carried out amid great difficulties and hardships. Since 1921 Mr. Rasmussen had embarked upon a prolonged expedition of the American Arctic Archipelago with a view to carrying out a systematic ethnological investigation of those regions—a project which he had evolved some eleven years before. The expedition was still in the field and was not expected to return before next year.

The society's other gold medal was awarded to the Hon. Miles Staniforth Smith for what the president described as a remarkable journey into the interior of Papua made in 1912, when Mr. Smith was administrator of that territory. It was, he said, especially fitting that the exploration of the inaccessible hinterland should have been carried through by an eminent citizen of the Australian Commonwealth.

The other awards were: The Gill Memorial.—To Captain Augiéras, who has traveled extensively in North-West Africa since 1913, with a view to lifting the veil from the little-known stretches of the Sahara.

The Murchison Grant.—To Captain A. G. Stigand, who had a long period of government service in Africa. In 1910 he became a resident magistrate for Nagamiland, and the particular piece of work which had earned for him the award was an admirable map of that country.

The Cuthbert Peek Grant.—To Mr. Frazer and Mr. Odell, the surveyor and the geologist of the Oxford expedition to Spitsbergen in 1921.

The Back Grant.—To Mr. B. Glanvill Corney, writer on geographical subjects and editor of four of the volumes of the Hakluyt Society.

AN OUT-OF-DOORS MUSEUM FOR THE UNIVERSITY OF MICHIGAN

AN anonymous donor has purchased for the University Museums, University of Michigan, a tract of land comprising 120 acres in Missaukee County, Michigan, for museum purposes. To this area has been added, by deed from the Department of Conservation to the university, 240 acres of tax homestead lands in two parcels, one of eighty acres and another of 160 acres. The eighty acres adjoins the original 120 acres, making a tract of 200 acres, which is close to the 160 acres. It is expected that the two tracts can easily be united in the future if this is considered advisable.

The whole tract has been deforested, but not cleared of the second growth and it is the site of many remarkable Indian earthworks, including two large circles, many Indian mounds and hundreds of pits. The principal purpose of the gift is to preserve the Indian remains and to make possible their detailed study by the Museum of Anthropology. The area is also to serve as a sanctuary for native animals and plants and as a place where experimental field studies may be carried on by the Museum of Zoology.

The earthworks will be restored after exploration and roads will be opened to the more conspicuous ones, so that tourists may inspect them under proper restrictions. In other words, the preserve will be an out-of-doors museum in the broadest meaning of the term museum, since it will preserve and exhibit the Indian remains and wild life and at the same time provide facilities for research.

ALEXANDER G. RUTHVEN

SCIENTIFIC NOTES AND NEWS

FOR the Roosevelt Memorial Association, President Harding presented on June 15 gold medals to Miss Louisa Schuyler, known for her philanthropic work; Professor Henry Fairfield Osborn, president of the American Museum of Natural History, and Major General Leonard Wood. In presenting Professor Osborn, Mr. Hagedorn said that Theodore Roosevelt had sought him out again and again "as the highest authority in a field that was dear to his heart."

A PORTRAIT of Professor A. A. Michelson, for over thirty years head of the department of physics in the University of Chicago, which was painted by Ralph Clarkson of Chicago, is to be a gift to the university from a large number of Professor Michelson's former students and friends. The portrait has been temporarily placed in the Quadrangle Club.

THE University of Cambridge will confer the degree of Doctor of Science on Wilder Dwight Bancroft, professor of chemistry in Cornell University; Ernst Julius Cohen, professor of chemistry in the University of Utrecht; Albin Haller, president of the Academy of Sciences of the Institute of France; Charles Moureu, professor of chemistry in the Collège de France; Raffaelo Naisni, professor of chemistry in the University of Pisa; Amé Pictet, professor of chemistry in the University of Geneva; and Frédéric Swarts, professor of chemistry in the University of Ghent.

THE University of Oxford will confer at the forthcoming commemoration on June 27 the honorary degree of doctor of science on Sir E. Rutherford, F. R. S., Fellow of Trinity College and Cavendish professor of experimental physics in the University of Cambridge, and on Dr. Louis Lapicque, professor of physiology in the University of Paris.

THE British Institution of Electrical Engineers has presented its Faraday medal for "notable scientific or industrial achievement in electrical engineering, or for conspicuous services rendered to the advancement of electrical science," to Sir Charles Parsons, the distinguished engineer.

THE David Livingstone Centenary Medal for 1923 has been awarded to Griffith Taylor, associate professor of geography in the University of Sydney, Australia. This medal, founded by the Hispanic Society of America and awarded by the American Geographical Society, is given "for scientific achievement in the field of geography of the southern hemisphere." The second Pan-Pacific Scientific Congress will meet in August and September of this year in Australia at which time presentation of the medal to Dr. Taylor will be made by the American Geographical Society's representative.

THE honorary degree of doctor of science was on May 31 conferred on Dr. Karl F. Kellerman, associate chief of the Bureau of Plant Industry of the Department of Agriculture, by the Kansas State Agricultural College. Dr. Kellerman is the son of William A. Kellerman, professor of botany in the college from 1883 to 1891.

PROFESSOR WARREN G. WATERMAN has been elected president of the Illinois State Academy of Science for 1923-24.

PROFESSOR D. M. MOTTIER, of the University of Indiana, has been appointed chairman of a committee for the state for the conservation of rare wild species of ferns and flowering plants.

THE Sigma Xi fellowship for the year 1923-24, with a stipend of $1,500 and $500 for expenses, has been granted to Professor Roy L. Moodie, of the College of Medicine, University of Illinois, Chicago. Professor Moodie expects to continue his studies in paleontology, working in various museums in California and the southwest.

THE Ricketts Prize of the University of Chicago for research in pathology, hygiene and bacteriology for 1923 is divided between Lauretta Bender and Robb Spalding Spray. Miss Bender receives a first prize of $300 for "Hematological studies in experimental tuberculosis of the guinea pig," and Mr. Spray a second prize of $50 for "A bacteriological study of pneumonias of sheep."

DR. R. B. MOORE, retiring chief chemist of the Bureau of Mines, was guest of honor at a luncheon on May 29, which was attended by a large number of his associates at the bureau.

WALTER M. BERRY, who has been chief of the gas engineering section of the Bureau of Standards, has resigned effective July 1 to be-

come engineer in charge of research of the California Gas Research Council.

A. H. HOOKER, of the Hooker Electrochemical Company, was elected president of the Manufacturing Chemists' Association at the annual meeting held in New York on June 5.

DR. VICTOR F. HESS, chief physicist of the United States Radium Corporation, has resigned to assume the chair of experimental physics at the University of Graz in Austria.

PROFESSOR COLIN G. FINK, head of the division of electro-chemistry, Columbia University, has been elected to honorary membership in the honorary engineering fraternity Tau Beta Pi. Dr. Fink has recently been granted letters patent on his insoluble cupro-silicon anode now in successful operation at the large copper works at Chuquicamata, Chile.

ERIC A. LOF, who since 1909 has been connected with the power and mining engineering department of the General Electric Company as industrial engineer and specialist, has resigned to take up work with the American Cyanamid Company.

THE representatives of the American Association for the Advancement of Science at the twenty-sixth annual meeting of the American Society for Testing Materials, to be held at Atlantic City, New Jersey, from June 25 to 29, are: George K. Burgess, director of the United States Bureau of Standards, and C. L. Warwick, secretary-treasurer of the society. At the exercises held during commencement week at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, the association is to be represented by Edward K. Strong, Jr., professor of education and head of the department of educational reference and research in the institute.

OFFICERS of the Linnean Society, London, have been elected as follows: *President,* Dr. A. B. Rendle; *treasurer,* Mr. H. W. Monckton; *secretaries,* Dr. B. Daydon Jackson, Dr. W. T. Calman and Captain J. Ramsbottom; *other members of council,* Dr. W. Bateson, Dr. G. P. Bidder, Mr. R. H. Burne, Professor F. E. Fritch, Professor E. S. Goodrich, Dame Helen Gwynne-Vaughan, Sir Sidney F. Harmer, Dr. A. W. Hill, Mr. L. V. Lester-Garland, Baron Rothschild, Dr. E. J. Salisbury, Mr. R. J. Tabor, Mr. T. A. Sprague, Professor F. E. Weiss and Dr. A. Smith Woodward.

DR. W. J. MAYO, of the Mayo Clinic, Rochester, Minnesota, who had conferred on him the honorary doctorate of laws at the recent commencement of McGill University, has sailed for Europe where the degree of master of surgery will be conferred on him by Trinity College, the University of Dublin and the degree of doctor of science by the University of Leeds. Dr. Mayo will present a paper on July 17 before the International Surgical Congress.

DR. HUGH S. CUMMING, surgeon general of the United States Public Health Service, has been attending meetings of the committee on health of the League of Nations held in Paris at the end of May.

A SCIENTIFIC mission, composed of Professor Moureu, chemist at the Collège de France, his son and an assistant, has left Marseilles for Madagascar to examine the radio-active deposits which have been discovered on the island and to ascertain the properties of the thermal waters at Antsirabe.

DR. ARTHUR D. LITTLE, of Cambridge, spoke on June 13 before the New York State Bankers' Association on "The chemistry behind the dollar."

DR. W. D. BANCROFT, professor of physical chemistry in Cornell University, gave an address entitled "A plea for research" at the house of the Royal Photographic Society, London, on June 5.

PROFESSOR H. R. KRUYT, who occupies the chair of physical chemistry in the University of Utrecht, recently gave a lecture upon the electric charge of colloids before the medical chemistry department of the University of Edinburgh.

MR. J. T. SAUNDERS, demonstrator of animal morphology at the University of Cambridge, is giving at Basle a course of twelve lectures on the "Basis of fresh water biology" in the university. Mr. Saunders is lecturing in French. These lectures are a return for those delivered by Professor Zschokke, of Basle University, last term in Cambridge on the "European fauna."

PROFESSOR E. W. D. HOLWAY, of the University of Minnesota, died at Phoenix, Arizona, on March 31, aged seventy years. He had recently returned from Brazil with large collections of fungi and flowering plants.

DR. A. LOOSS, formerly professor of parasitology in the School of Medicine, Cairo, died on May 4, aged sixty-two years.

MR. M. DE C. S. SALTER, superintendent of the British Rainfall Organization, died on May 21, aged forty-two years.

CAPTAIN CARL HARTVIG RYDER, director of the Danish Meteorological Service, died on May 3.

COLONEL GEORGE FALCONER PEARSON, distinguished for his work on forestry in India, died on April 25, at Kington, Herefordshire, aged ninety-six years.

ON June 7, at the Brooklyn Botanical Garden, was unveiled the Alfred T. White Memorial. This consists of a semi-circular seat of stone facing a tablet of serpentine rock bearing a bronze bas-relief six feet high by five and one half feet wide, by Mr. Daniel Chester French. At the right of the design is the figure of a woman, seated, with a small child beside her. In her lap is a partly completed wreath of mountain laurel, and she is reaching forward to pluck a branch from a laurel bush in blossom on the opposite side of the plaque beneath an oak. The seat and tablet were designed by Mr. Henry Bacon, who was the architect of the Lincoln monument in Washington. The memorial was a gift from former associates and friends of Mr. White.

WE learn from *Nature* that at the annual meeting of the Institution of Electrical Engineers May 31, there was presented to the institution: (1) an oil painting of the late Dr. Silvanus Thompson (presented by Mrs. Thompson); Dr. Thompson's library (presented by a number of members of the institution and others); and (2) a bronze bust of Dr. Thompson, by Mr. Gilbert Bayes (presented by the Finsbury Technical College Old Students' Association).

A PRELIMINARY announcement regarding the general discussion on the electronic theory of valency arranged by the Faraday Society, to be held at Cambridge on July 13-14, has been issued and is summarized in *Nature*. Professor G. N. Lewis, of the University of California, will open the proceedings on the Friday afternoon with a general introductory address and he will probably be followed by Mr. R. H. Fowler, with a paper intended to open discussion on the physical and inorganic side of the subject. Among those expected to speak are Sir J. J. Thomson, who will be in the chair; Sir Ernest Rutherford, Sir William Bragg and Professor W. L. Bragg. The Saturday morning session will be devoted chiefly to applications of the theory in organic chemistry. Sir Robert Robertson, president of the society, will preside, and opening papers will be given by Professor T. M. Lowry and Dr. N. V. Sidgwick. Among those expected to speak are Professor W. A. Noyes, Sir William Pope, Professor A. Lapworth, Professor I. M. Heilbron, Dr. W. H. Mills, Professor J. F. Thorpe and Professor R. Robinson. On the Friday evening a complimentary dinner will be given to Professors Lewis and Noyes and other guests at Trinity Hall.

DR. FRANCIS G. BENEDICT, director of the Nutrition Laboratory of the Carnegie Institution of Washington, Boston, is visiting research institutions and particularly physiological laboratories in the principal countries of Europe. An address on the work of the Carnegie Institution of Washington in general and the Nutrition Laboratory in particular was given by Dr. Benedict in the new amphitheater of the Société Scientifique d'Hygiène Alimentaire in Paris on April 14. At a joint meeting of the Biochemical and Medical Societies of Berne, on April 30, a lecture on the recent work of the Nutrition Laboratory on basal metabolism and insensible perspiration was given. An address on the simple method of determining the gaseous metabolism in man, recently devised by Dr. Benedict and Mrs. Cornelia Golay Benedict, was delivered on May 14 at Heidelberg, before the Naturhistorisch-medicinischer Verein, together with a discussion of normal basal metabolism. In Halle on May 16 an address was given before the faculty and students of the medical department of the university on the determination and significance of basal metabolism in clinical medicine. After visiting Berlin, Sweden, Finland, Denmark, Holland, Belgium and

England, Dr. and Mrs. Benedict will attend the International Congress of Physiology at Edinburgh, returning to Boston in August.

THE station budget for the year 1923-24 of the New York Agricultural Experiment Station at Geneva, New York, carries a total of $250,035, an increase over that for the past year of $31,585. Of this sum, $16,800 is specifically appropriated for special research in horticulture in the Hudson River Valley. No permanent sub-station is to be established, only temporary field laboratories wherever the problems demand close attention. The work will be under the direction of the station at Geneva and three new positions on the station staff have been created to take care of the new lines of work. These positions will include associates in research in entomology, horticulture and plant diseases. These appointments will take effect July 1 next. Three new positions have also been created on the staff at Geneva, beginning with July 1. Two of these will be assistants in research in dairying and one a laboratory technician. Provision is made for the publication of "The small fruits of New York," the next in the series of fruit books published by this station. Work is already under way on this book. The bill providing for the administration of the Geneva station by the trustees of Cornell University has been signed by the governor and will take effect July 1. The present board of control will be abolished and the station will be administered by Cornell University, but with a director and staff as heretofore.

THE Mexican government is making special arrangements for the several scientific expeditions expected to visit Mexico to make observations of the total eclipse of the sun next September. Camille Flammarion, director of the Paris Observatory, has notified the Mexican government that he will head an expedition which probably will establish headquarters in Durango. Dr. Albert Einstein may go to Mexico to observe the eclipse. Among Americans who will visit Mexico are Dr. John Miller of Sproul Observatory, Swarthmore, Pennsylvania, and Dr. Douglas of the University of Arizona. The eclipse will have a path of about 105 miles, passing from the islands off the coast of California through Sonora to Durango. Dr. Douglas expects to establish his expedition in Lower California. The northern limit of totality will lie one mile to the northeast of Santa Barbara.

ANNOUNCEMENT of personnel and plans of the committee which is to direct a national investigation of the storage of coal in cooperation with the United States Coal Commission, the Department of Commerce and the Bureau of Mines is made by the Federated American Engineering Societies. The committee members are: H. Foster Bain, director of the United States Bureau of Mines, Washington; David Moffat Myers, former fuel administrator, New York; Perley F. Walker, dean of engineering, University of Kansas; W. H. Hoyt, chief engineer of the Duluth, Missabe and Northern Railway, Duluth, Minn.; S. W. Parr, professor of applied chemistry, University of Illinois; Edgar S. Nethercut, secretary of the Western Society of Engineers, Chicago; Roy V. Wright, editor, New York. The chairman is W. L. Abbott, chief operating engineer of the Commonwealth Edison Company of Chicago. This main committee, it was stated by Dean Mortimer E. Cooley, of the University of Michigan, president of the Federated American Engineering Societies, will work with committees in every state, studying local conditions through local engineers in an effort to find a solution for the problems of coal consumers from the small households to the largest industries. Thirty national and local engineering societies, members of the federation, have been enlisted in the work and will be aided by other engineering groups, state administrative committees, federal and state agencies, private enterprises, civic bodies, corporations and individuals. The investigation, the first of its kind to be undertaken in this country, will deal with the whole range of problems affecting the storage of coal.

THE Tortugas Laboratory of the Carnegie Institution of Washington will be open for two or three months during the present summer in order that investigators who have formerly undertaken researches in association with the department of marine biology of the institution may be afforded an opportunity to continue such investigations with a view to the completion of their studies for purpose of publication. It is expected that Dr. Paul Bartsch, of the

United States National Museum; Dr. W. H. Longley, of Goucher College, and Dr. A. A. Schaeffer, of the University of Tennessee, will pursue investigations at Tortugas in accordance with this plan. The equipment of the laboratory will be in charge of Mr. John W. Mills, engineer of the Department of Marine Biology.

THE second annual session of the Rocky Mountain Biological Station began on June 11 and continues until August 24. The second half begins on July 19. The station is located at Gunnison, Colorado, close to the continental divide and is conducted as a part of the Western State College of Colorado. The staff for 1923 is: Dr. John C. Johnson, of Western State College, director; Dr. J. D. McDonald, of California State College; Mr. J. P. Eskridge, formerly of Silliman Institute, Philippines; Mr. C. R. Walker, of Western State College; Mr. C. T. Hurst and Miss Virginia McCleary, assistants; Dr. Charles A. Kofoid, of the Universiy of California, special lecturer, July 23-27. The greatest emphasis will be placed upon parasitology and animal and plant ecology, although the standard courses in botany and zoology will also be given.

THE National Association of Manufacturers of Carbonated Beverages has established at the Iowa State College a fellowship in food and sanitary chemistry which will carry a stipend of from $2,000 to $2,500 for the next two years. Professor Buchanan, in charge of food and sanitary chemistry, will direct the work.

THE Hammermill Paper Company, through their chemical director, Dr. Bjarne Johnson, has offered to the trustees of the New York State College of Forestry a fellowship for the coming year of the value of $1,200 to be known as the "Hammermill fellowship in pulp and paper manufacturing." The fellowship has been awarded to Mr. Burton L. Kassing, of Utica, New York.

MESSRS. NORTON AND GREGORY, Limited, London, manufacturers of drawing and mathematical instruments, etc., are offering two engineering scholarships to be competed for annually, one value £100 per annum and one value £50 per annum, tenable for three years at any university in the United Kingdom or British Dominions approved by the honorary committee, of which Sir Joseph Petavel, F.R.S., director of the National Physical Laboratory, Teddington, is the chairman. The object is to assist those who are unable to take up a complete course of engineering at a university owing to lack of the necessary funds.

GOVERNOR COX has signed a bill to authorize the trustees of Northeastern University of the Boston Young Men's Christian Association, "to confer such degrees as are usually conferred by colleges and universities in this commonwealth, except medical and dental degrees and degrees of bachelor of science and bachelor of arts, and to grant diplomas therefor."

Nature writes: "Scientific workers are too well acquainted with the value placed on their services to be surprised at an advertisement for a university assistant lecturer in a department of science at a salary of £300 a year. Recently, however, such an offer provoked an indignant protest from a disinterested member of the general public, who stated to us that the remuneration of his chauffeur was on a more liberal scale. While it is true that any educated man with aspirations would prefer a university teaching post, with its vague promise of an interesting and useful career, to the more mundane occupation, it is nevertheless a matter of the gravest concern that those educational institutions which are engaged in the task of increasing and disseminating knowledge are in such a parlous financial position that they are forced to offer salaries bearing no relation to the status of the posts, and imposing on their holders an unfair burden of financial sacrifice. The greatest benefactors of the universities are still the members of the teaching staffs themselves."

THE British Colonial Office has announced that the vessel *Discovery* has been purchased by the Crown agents for the colonies on behalf of the government of the Falkland Islands, to be employed principally in research into whaling in South Georgia and the South Shetlands. The London *Times* notes that there is a very large whaling industry in these dependencies and knowledge in regard to the numbers and habits of the whales is insufficient to enable the industry to be controlled in such a way as to

afford security against depletion of the stock. The principal task for which the *Discovery* will be employed is to ascertain the geographical limits of the whales, to trace their migrations and to form some idea of their numbers and the rate of reproduction. But the expedition will also afford opportunities for adding to scientific knowledge in many other directions and particularly in oceanography, meteorology and magnetism. As the *Discovery* will require extensive reconstruction, it is not anticipated that she will be ready to sail before next year. The enterprise will be carried out under the instructions of the Colonial Office, and the Duke of Devonshire is taking steps for the appointment of an executive committee to undertake the management. It is proposed that the Colonial Office, the Admiralty, the Ministry of Agriculture and Fisheries, the British Museum (Natural History) and the Royal Geographical Society should be represented upon the executive committee. The committee will keep in close touch with other institutions and individuals who are interested in Antarctic research. The *Discovery*, a strong wooden ship of about 700 tons register, was built at Dundee for Captain R. F. Scott's expedition to the Antarctic, which started in 1901. The ship was frozen in at its winter quarters and Scott received orders to abandon her and return in the relief ships sent, but the *Discovery* broke out of the ice in February, 1904, and Scott brought her home in perfect order.

THE governments of South Africa, Australia, the Argentine Republic and possibly the United States will cooperate with Great Britain in an Antarctic expedition, preliminaries of which are being discussed. In all probability plans will be completed in London.

UNIVERSITY AND EDUCATIONAL NOTES

ANNOUNCEMENT was made at commencement at Lafayette College, by President John H. MacCracken, of the gift of $200,000 by Mr. John D. Larkin, of Buffalo, to endow "The John D. and Frances H. Larkin professorship of chemistry." In accordance with the conditions of the trust, four fifths of the income is subject to an annuity for one life, the other one fifth of the income will be immediately available for the work in chemistry.

THE Michigan College of Mines has received a gift of $10,000 from Dr. Edgar Kidwell, head of the Kidwell Boiler Company, of Milwaukee, for the founding of a scholarship in memory of his son, who was killed in the war. Dr. Kidwell was formerly professor of engineering in the college.

DR. EDGAR FAHS SMITH, formerly provost of the University of Pennsylvania, laid the cornerstone of the new chemical laboratory of the Rice Institute, Houston, on June 4. The laboratory, which will be erected at an approximate cost of $1,000,000, will be ready in September, 1924.

PROPOSALS for the removal of Randolph-Macon College to Norfolk and for its consolidation with American University at Washington have been rejected by the board of trustees, following a meeting attended by members of the faculty and alumni of the institution.

JOHN H. MUELLER, Ph.D., associate professor at the College of Physicians and Surgeons, Columbia University, has been appointed assistant professor of bacteriology at the Medical School of Harvard University.

DR. LESLIE A. KENOYER, assistant professor of botany in the Michigan Agricultural College, has been chosen professor of biology at the Western State Normal School, Kalamazoo, Michigan.

MR. J. T. SAUNDERS, senior fellow of Christ's College, Cambridge, and demonstrator of animal morphology, has been elected tutor of Christ's College, in succession to Dr. F. H. A. Marshall, F. R. S., who has resigned.

DISCUSSION AND CORRESPONDENCE

NOTE ON PREPARING COLOR STANDARDS

WHEN it is desirable to develop a colorimetric method for measurement of the small amounts of substances met with in biological studies the worker must frequently devise his own color standards. After a color has been matched to that produced by the substance to be

detected a colorimeter may often be employed for the determinations. But when a colorimeter is prohibitive, a series of tubes ranging by the smallest perceptible variations in color may prove satisfactory.

One difficulty in preparing a set of tubes in this fashion lies in the fact that to the unaided eye a change in color is less noticeable between deep colors than the same change between diluted ones. This is apparently a geometric relationship, as demonstrated in an article[1] recently published by the author.

This finding is not at variance with that of Lovibond.[2] But it is not necessary to have recourse to a "specific color factor" for practical purposes, as it is only essential to dilute the colored solution sufficiently to ascertain roughly the number of tubes required for a geometric series that will fulfill the requirements at hand.

Having a colored solution that matches the heaviest shade of the substance to be estimated, we dilute an aliquot with an equal volume of water, part of this we dilute again, etc., till there is but a perceptible difference in shade between our last two dilutions. We can then calculate the number of tubes required for the series and may ascertain the factor for the set, using the formula

$$r = \sqrt[n-1]{\frac{1}{a}}$$

Of course, the number of tubes required to complete a series graded by the nearest perceptible change in color will vary as the intensity of the terminal solution and in the case of a very weak solution many less tubes will be necessary than in a strong one. Then, too, if the grading is through a definite number of tubes rather than by intensity of color and the tubes are too few in number, these large jumps in color by reason of their geometric relationship may give rise to errors when interpolating, especially in the deep colors. The size of the factor rests somewhat on the degree of accuracy desired in reading between tubes.

It is suggested that color standards may be more easily and reliably prepared in the manner outlined above than by matching or diluting by the unaided eye.

ARTHUR P. HARRISON
BUREAU OF PLANT INDUSTRY

A FACTOR CAUSING THE ASSIMILATION OF CALCIUM

IN the work of Dr. Forbes, formerly of this station and the earlier work of Hart and his associates and of Meigs and his associates it has been demonstrated that milking cows receiving a ration of grain and dry hay, with and without mineral supplements, are brought into a decided negative calcium balance. Hart has also shown that goats, after a period of negative calcium balance, have been able to produce a positive calcium balance when placed on green feed. He states that apparently there is something having its source in fresh green material which controls or assists calcium assimilation.

Working on the hypothesis that most of the calcium, in whatever combination it may be, in the cells of green plants is in a highly dispersed form and hence better assimilated than the calcium in the dry plant, the drying of which no doubt causes a change in the physical properties of the cell and its content, we set about to imitate, in a rough way, the cell content as far as it represents our idea of the highly dispersed form in which the calcium exists in green plants. A starch paste was made up with a known solution of $CaCl_2$ (2 Molar). Then an equal volume of Na_3Po_4 of the same strength as the $CaCl_2$ was added. The starch acted in a slight degree as a protective colloid for the calcium ion and the final product, Ca_3 (Po_4) was left in a highly dispersed form. This starch paste was added to the ration of grain and dry timothy hay, which in turn was fed to two milking goats.

The goats were mature animals in their third and fifth months of lactation and weighed 30 and 40 kilograms respectively.

This test was carried on for a period of 26 days preceded by a preliminary period of 10 days. The 26 day period was divided into three periods of 7, 7 and 12 days respectively. The calcium intake was from 5 to 6 grams per day. Out of the six complete accountings of the calcium five were positive, the sixth showing a negative balance of 0.32 grams calcium for

[1] "Geometric progression in optically prepared standards," *J. Amer. Op. Soc.*, May, 1923.

[2] Lovibond, J. W., "Light and color theories," 1915, Appendix II, p. 77.

the 12 days. This was a little surprising to us after we had failed, in a previous trial, to obtain a positive calcium balance on a dry ration and a mineral supplement. We realize that the goats were in a later stage of lactation in this trial than in the one two months previous, when a negative calcium balance was obtained, with practically the same intake, yet we do not believe that this difference can be entirely attributed to this factor.

A vitamin or the vitamins of green plants may play an important part in the assimilation of calcium, yet we do believe the difference between green (fresh) and dry plants in causing the assimilation of calcium is partly due to the difference in physical properties of the cell wall and the cell content.

Our data are not yet inclusive enough to substantiate our hypothesis or to draw definite conclusions.

CHAS. H. HUNT,
A. R. WINTER
OHIO AGRICULTURAL EXPERIMENT STATION,
WOOSTER

TRABECULAE OF SANIO IN ANGIOSPERMS

THE occurrence of "Trabeculæ of Sanio" has been noted previously only in Gymnosperms but their discovery in an Angiosperm at the Forest Products Laboratories of Canada demonstrates a wider distribution than hitherto has been credited to these rod-like structures which extend across the lumina of cells.

Typical trabeculæ—homologues of those common to Gymnosperms—were observed extending radially throughout a series of tracheids in secondary wood from the stem of *Alnus oregona*, Nutt. One section of this alder shows a series of trabeculæ which, as well as crossing a number of tracheids, traverses the lumen of a wood parenchyma cell.

Generalizations regarding a primitive position for the Betulaceæ which are based on the occurrence of trabeculæ in members of this group must be hazardous as the ubiquitous distribution of these typically rod-like structures in the Gymnosperms leads to the presumption that they may be of widespread occurrence in the Angiosperms as well.

J. D. HALE
FOREST PRODUCT LABORATORIES OF CANADA,
MONTREAL

A COURSE IN PHYSICAL MEASUREMENTS FOR STUDENTS IN OTHER SCIENCES

IN the issue of SCIENCE for August 29, 1919, a plea was made by Dr. Paul E. Klopsteg for courses in physical measurements for students of chemistry and related sciences. In view of the inherently physical nature of almost all quantities which can be observed and evaluated, the reasonableness of such a plea seems obvious. The emphasis of the writer was upon the need of training in physical measurements as differentiated from "physics."

During the past semester we have offered a course of this type and it seems advisable to add our experience to the plea made by Dr. Klopsteg. The section has consisted of ten men, seniors and juniors, whose major interests have been in astronomy, chemistry, engineering and mathematics. All have pursued a course in general physics which included a year of laboratory practice of the ordinary college type. Each one has had laboratory experience, more or less extended, in some other science.

The material for the course was determined by choosing from the instruments commonly employed in the physical laboratory those which were judged to have application in other fields. Opportunity was given for becoming familiar with each instrument by using it for some particular determination. The method of its use was stressed rather than the quantity which was being determined. For instance, the potentiometer was studied in principle and one was used in calibrating a thermocouple. The choice of instruments has been influenced by the resources of the laboratory and the list here given is not to be taken as a final selection. In each case the particular use to which the instrument was put has been indicated.

1. The Pulfrich refractometer for the index of pure liquids, solutions and solids.

2. The prism spectroscope with photographic registration of an "unknown" and a comparison spectrum, measured with a comparator.

3. The alternating current bridge and galvanometer for electrolytic conductivity, using an electrically controlled thermostat.

4. The Carey-Foster bridge for the checking, coil by coil, of a decade box against a standard.

5. The potentiometer in the calibration of a base metal thermocouple.

6. The Kelvin double bridge (Wolff type) in calibrating a platinum resistance thermometer.

7. The MacLeod gauge, with double range, measuring the pressure produced by an oil and a mercury diffusion pump in the various stages of the discharge in an attached Geissler tube.

8. The triode amplifier. Its static characteristics and its amplifying factor were measured. Its application was discussed but not made.

The emphasis of the course has been upon the use and application of specific instruments and upon the principles governing measurements in general and not upon the physical theory involved in the experiments. It is debatable how far this distinction may be carried with profit, but our first experience seems to justify for such students this type of course. There is no doubt of the appeal which it has made to the men and of their conviction of its value in preparing them for their chosen fields. We feel that physicists owe it to their fellow-workers to make their instruments of precision more widely known and propose courses of this general nature as a step in that direction.

WINTHROP R. WRIGHT
SWARTHMORE COLLEGE

BIOLOGICAL RECORD CARDS

FOR a number of years there have been in use in the zoological laboratory of Harvard University small record cards of the standard library size (75 m.m. by 125 m.m.), similar to the first of the illustrations printed below. These were devised primarily for use in keeping permanent card records of the treatment of histological and embryological material, but are serviceable for recording any procedure or experiment with animals or plants in which a time record is important. The time-saving helpfulness of such cards has been recognized by persons in other laboratories and this has suggested the possibility that the cards might be useful in many laboratories if they were readily procurable.

The method of use is shown in the second of the accompanying illustrations. The serial numbers indicate successive steps in the treatment of the object. The *printed* numerals are the "units" only; the "tens" are to be *written* in front of each "0." By ignoring the last four lines, the steps in a series can be carried to any desired number, the second card beginning with step 21, the third with 41, etc.

In the column headed "Reagents," abbreviated names can be used and, if one desires, small rubber stamps may be procured for the more common reagents, as illustrated in parts of lines 3 and 16-19. Sometimes several methods may be indicated on a single stamp, all except the one employed being stricken out, as in 17, where the staining was in Ehrlich's haematoxylin.

The time record shows the instant at which the treatment begins, it being assumed that that treatment continues till the beginning of the next following one. The period during which any treatment lasts is *not* to be recorded; but can be determined at once by noting the difference in time between the beginning of the treatment and the beginning of the one next

	REAGENT	MO.	DA.	HR.	MIN.
1					
2					
3					
4					
5					
6					
7					
8					
9					
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
0					
1					
2					
3					
4					

E. L. M.

Fig. 1

5 mm. cube. No. 27. 59.79: 14.36

REAGENT 1921	MO.	DA.	HR.	MIN.
1 Zenker	9	20	9	15
2 H_2O, running		21	9	00
3 alch. 50% iod.		22	8	15
4 " 70% "		"	10	00
5 " 90%		"	15	10
6 " 100%		23	8	00
7 " " + xylol		"	9	50
8 xylol		"	10	30
9 " + paraf., soft 45°		"	11	15
10 paraf., soft 45°		"	11	45
1 " hard 52°		"	12	15
2 imbed., block		"	12	45
3 sectioned 8μ 10		3		
4 affixed, albumen		"		
5 xylol		4	8	05
6 alch. 90, 70, 35%		"	8	10
7 haem. ~~Del.~~ Ehr. ~~Heid.~~		"	8	25
8 ½% eosin, alch. ~~95~~ 70%		"	11	30
9 alch. 80%		"	11	33
20 " 100%		"	11	34
1 xylol		"	11	35
2 " - damar		"	12	00
3 Cover				
4				

Microtus maculatus Raf. Liver. t.c.v.

Fig. 2

following. It is important to avoid the use of A. M. and P. M., which may best be done by adding 12 to the afternoon hours, which thus become 13, 14, 15, etc., instead of 1 P. M., 2 P. M., etc.

The three blank spaces at the margins of the cards can be used to suit the needs of the individual. The suggestions offered by the accompanying sample imply filing the records as with bibliographic cards. The long margin carries the name of the animal[1] (or plant) and also that of the organ. If the Dewey decimal system, as expanded by the *Concilium Bibliographicum*, is used for the systematic arrangement of the cards, the space in the upper left-hand corner may receive the numerals, as in the sample, where "59.79" represents "tailed amphibia" and "14.36" stands for "anatomy of the liver." In the shorter margin "No. 27" indicates the number of the individual (or organ) treated in this manner and "5-m.m. cube" shows the size of the object so treated.

The printed cards are of heavy ledger paper and can be had by the hundred or thousand from the Harvard Cooperative Society, Inc., Harvard Square, Cambridge 38, Mass.

E. L. MARK

[1] For maculatus read maculosus.

AEROBIC

DR. KEEN'S rejoinder to my comments on his proposed spelling of the word aerobic (SCIENCE, May 11, p. 559) can hardly pass unnoticed. He states that I have misread his letter (SCIENCE, March 23, p. 360) and that he "urged the retention of the aer as a disyllable." Referring again to his first letter, I find that Dr. Keen used the diphthong four separate times in this connection and no reference whatever is made to a "disyllable." With regard to the spelling of dissylable to which Dr. Keen takes exception I find that Webster's New International Dictionary gives only the spelling with double s. If Dr. Keen will refer again to my letter he will fail to find the spelling "dipthong" to which he objects.

ARTHUR W. DOX

DETROIT, MICH.

QUOTATIONS

THE ZOOLOGICAL RECORD

THE decision of the Zoological Society's council to discontinue the publication of the *Zoological Record* on the grounds of expense suggests somewhat opposing thoughts. It is generally admitted, or even strongly urged, by most workers in every branch of science that some guide to the ever-increasing flood of literature is a necessity. If this was true in 1865, when the *Zoological Record* was started, it is no less true to-day. The need, in fact, must have increased in at least the same direct ratio as the number of publications. Yet in zoology, as in geology and other sciences, these guides, records and indexes have had a perpetual and severe struggle for life, in the course of which many have from time to time succumbed, been revived under another form and too often again collapsed.

The *Zoological Record* itself was begun in 1865 as a publication by Van Voorst, under the editorship of Dr. Albert Günther, with a distinguished staff of recorders. The publisher paid for the printing, but the manuscript, we believe, was compiled for nothing. Mr. Van Voorst soon found the loss too great, and, though he continued as publisher, an association was founded in 1871 to guarantee the expenses. This carried on till 1887, when the *Record* was saved from extinction by the Zoological Society, which generously shouldered the burden and bore it unaided until the establishment of the International Catalogue of Scientific Literature. The question then arose whether the record of zoology should merely become one part in that vast scheme. Fortunately the secretary of the Zoological Society was far-sighted enough to preserve the continuity and title of the record and the control of the society, by inducing his council to contribute largely to the expense and to maintain its record committee. Consequently, when the International Catalogue failed, and when the Royal Society declined to undertake the huge expenditure on what had virtually become its sole responsibility, then zoologists still found their record appearing—retarded and weakened, but in being and ready to resume its old strength and value whenever they themselves would provide the necessary sustenance. Unfortunately, the increased costs of production have coincided with the loss of a number of subscribers owing to the effects of war and its *sequelæ*. The secretary of the Zoological Society has over and over again sought in various directions to supply this loss, but has not met with any cheering response. All these facts must be remembered before we venture to blame the society for its present decision. * * * *

For thirty-six years the Zoological Society has earned the thanks and praise of zoologists for its support of this indispensable aid. But zoologists at large must now do their share if they wish this support to continue. On their side, as well as on that of the recorders, there must be a little more enthusiasm and self-sacrifice. The vessel is stranded, but with good will from all hands she can be kept afloat till the high tide returns. If the workers will give some real earnest of this good will, we can not believe that the society which has so long served as pilot will leave her to be broken up.—*Nature.*

SCIENTIFIC BOOKS

THE NEW VOLUMES OF THE ENCYCLOPAEDIA BRITANNICA

My experience as a reader of the *Encyclopædia Britannica* has been so intimate and long continued that I may perhaps be allowed to undertake what no one person can do perfectly, namely, the writing of a review of the three new volumes which were recently added to the twenty-nine volumes of the eleventh edition to convert it into the twelfth.[1] A lifetime given wholly to the study of such an extensive and varied work would not suffice as a suitable preparation for analyzing it adequately. It was the ninth edition which first stimulated my intellectual life and afforded me the earliest means of entry into the wealth of the world's culture; and I have never ceased to look upon this magnificent work with affection and gratitude. The eleventh edition marked an immense improvement over the preceding ones, excellent as these were; and it gave me a new lease of enjoyment of the intellectual heritage of our humankind. My occasional and partly systematic reading of the *Britannica* during the last eleven years has taken me through more than ten per cent. of this eleventh edition, and I have now read nearly as large a portion of the new volumes.

It is needless to say that in the field of my specialty the *Britannica* is too brief to serve my purpose. If it was sufficient for the specialist in every field it would be too large for general use and would lose its primary value as a storehouse of that knowledge and culture which is available and suitable for the general needs of educated men and women everywhere. The chief value of every such work must consist in the fact that it makes available to all intellectually minded persons the most important achievements of human thought and action in every division of endeavor which is essential to the civilization of the time. The contri-

[1] *The Encyclopædia Britannica*, The New Volumes, constituting, in combination with the twenty-nine volumes of the eleventh edition, the twelfth edition, 1922.

butions must therefore be broadly conceived and the work must be executed along lines which are not too technical. This is difficult if one is to achieve the character of authoritativeness which is necessary if the work is to be consulted with confidence. With respect to these ideals of clearness, of non-technicality, of authoritativeness, the eleventh edition of the *Encyclopædia Britannica* has succeeded more fully, I believe, than any other publication in any age or in any language; and the new volumes, under the same editorial management as the eleventh edition, have maintained a similar excellence.

In the 155 years since the *Britannica* made its first appearance in 1768 there has been a single occasion on which a new edition or a supplement to a previous edition appeared under circumstances comparable to those which existed at the time of the publication of these new volumes. During the years 1816 to 1824 there was published, under the editorship of Macvey Napier, a six-volume "Supplement to the fourth, fifth and sixth editions." This supplement was conceived in response to the pressing demand for a review of the world's situation immediately after the great wars of Napoleon which had just ended at Waterloo in 1815. It formed the only critical and universal survey then available for the troubled period to which it referred. Much of the information brought together in this supplement was of permanent value; and some of it could never have been procured if it had not been put on record at that time.

A similar need and a similar opportunity lay before Hugh Chisholm, the present editor of the *Britannica,* as he (just a hundred years later) undertook the task of organizing the material for the "new volumes" to cover the period from 1910 to 1921. He had an important advantage over his predecessor. The new volumes were prepared simultaneously and their publication took place practically at once. The whole work could therefore be under editorial supervision at one time. This gives greater unity to the text and puts the entire work at once into the hands of the reader.

There exists at present no other work comparable to these new volumes as a survey of the period of the Great War. They are arranged, as the editor says, "so that the articles may be adapted either for continuous reading or for occasional reference." They "have been planned as a guide to an appreciative understanding of contemporary affairs." In these volumes "the reader has before him what may be described as an international stock-taking" based on the comprehensive view of human culture afforded by the eleventh edition. There is never a way to understand the present, and especially a present so complicated as ours, except by seeing it in the light of the past. "The eye which looks only at the passing scene is too often color-blind." Our post-war world cannot be understood without a knowledge of our pre-war world. To behold current events in perspective we must employ the searchlight of the past. In this respect the preparation of the "New Volumes" was greatly facilitated by the existence of the eleventh edition completed only a short time before the outbreak of the Great War. No such cross-section of human progress as that contained in the eleventh edition could be taken now or can be taken at any time for some years to come. It is particularly fortunate that that great work was produced near the end of the long period of calm preceding 1914 when men could give themselves coolly to the task of evaluating the elements of human progress. The existence of such a work as the basis and starting-point of the "New Volumes" gives them an important advantage over any other survey of the war period likely to be produced in the near future. These new volumes are therefore an almost essential prerequisite to the needed stock-taking of our times.

The break-up of society following the Great War has so much turned attention everywhere to conditions of urgency and emergency and has so concentrated thought upon the immediate conduct of life and has so reduced experts everywhere, both in scholarship and in science, to the necessity of living (as it were) from hand to mouth and has so interrupted or suspended the accustomed intellectual activities that it has become a difficult matter to find intellects which are ready for the task of constructive analysis necessary to produce a work which meets the standards of the *Encyclopædia Britannica.* In this difficult undertaking the

editor has succeeded remarkably well. He has even been able to revive something of the international cooperation which was so useful in the preparation of the eleventh edition. The English speaking portion of the more advanced part of the world has been less dislocated from its intellectual foundations than any other portion; it is therefore natural that the first carefully planned universal stock-taking since the war should be carried out by them. Nowhere else has it yet become possible for such a work to be performed adequately.

It is inevitable that the Great War should loom large in these new volumes, and it is equally inevitable that they should be prepared under the assumption and the conviction that the war "was won by those who had right and justice for their cause" and "the historical justification for this belief is indeed given in the proper articles." By starting with the article on "The World War" and by employing the summary and references given in it the reader may easily organize for himself a systematic course giving an elaborate and authoritative history of the whole conflict.

Necessarily, the war and those things which grew out of it hold a prominent place throughout the "New Volumes"; it is this which gives to them a large part of their value. But the work as a whole is much more than a history of the war, much more indeed than the larger general history of the whole period of the war. All aspects of human progress and culture and knowledge for the period of 1910-1921 are taken into account; and the roots of some of the recent developments are traced far back to their beginnings. In this way some deficiencies of the eleventh edition are removed, as in the articles on Relativity, Protozoology and Nomography, for instance. The filling in of these gaps increases the usefulness of the earlier volumes and serves to complete the survey afforded by them. It is a matter of considerable surprise to me that so few of these gaps have been discovered. I do not know of any that escaped attention, and yet the number of important gaps filled in is very small. This makes clear as nothing else could the extraordinary adequacy of the eleventh edition.

Where the range of subject matter is so great as that in an encyclopedia a selection of the more valuable articles made by any one person will necessarily reflect his interests more than the character of the work itself. But it may be worth while to mention a few of the special topics which attracted my attention other than those dealing with the history of the period. No attempt will be made to indicate the more important articles as such; I intend rather to select some which appealed to me, and particularly those which one might perhaps overlook if his attention was not directed to them.

The article on Protozoology goes back to the beginning of that science; the account of its subject given in it affords very fascinating reading. In the article on Agriculture there is an equally interesting and related section on the "Progress of scientific research." The article on Geology should have many readers; this is especially true of the first two divisions of it. That on Anthropology is remarkable; in it we have a different view of the subject from that given in the eleventh edition. Under the heading of Relativity is found a brief and clear account of a modern subject which has attracted more general attention perhaps than any other subject in science has ever drawn to itself. Some of the surveys of recent national literatures are very entertaining; others are less so, and some are perhaps even a little disappointing. The articles on the electrical properties of gases and the constitution of matter are masterpieces of scientific writing. An excellent account of the League of Nations is given. The articles on Philosophy, Psychical Research and Palaeontology are fascinating. That on Zoology is a masterpiece. The one on mathematics is very pleasing, but the greater portion of it is too technical for one not well versed in this exacting science. Among other articles which I found very interesting are the following: Cytology, Archaeology, Astronomy, Botany, Chemistry and Embryology. In a survey which reviews the principal sciences under their general names it is somewhat surprising to find no article with the title Psychology. By some this may be counted a real omission. But there is an interesting article on Behaviourism. That this in a way takes the place of an article on psychology is significant of certain present tendencies in psychological

investigations—tendencies which (in my opinion) are likely soon to give way in part to those in the opposite direction.

My examination of these volumes has revealed remarkably few defects. The index will probably not prove to be as good as it might have been made, if one may judge from the omissions detected by looking occasionally to the index for references to interesting passages which were being read. One misses the "Classified table of contents" promised on the title page to the last volume but not supplied (at least in the copy I have and in one other which I consulted). The few pages required for this would have added greatly to the value of the work as a whole. But the defects are so few and the merits are so many that one should probably forget the former in his enjoyment of the latter. The distribution into articles is along the lines of an almost ideal arrangement; and the articles which I have read maintain generally a very high degree of excellence.

It remains to mention one other feature which should commend the work to all English speaking peoples. We may put this in the words of the editor, as given in the preface. "In the material structure of the New Volumes, and their sub-editing, the same note of Anglo-Saxon solidarity is struck as in the Eleventh Edition; and this is again emphasized by their being dedicated jointly to the two Heads of the English-speaking peoples, by express permission of King George V and President Harding. Nowhere except in Great Britain and the United States would it have been possible, under the world conditions of 1921, to find the standard of poise and perspective required in their construction." In concluding his preface, written after twenty-one years of continuous service as editor of the *Encyclopædia Britannica*, Hugh Chisholm says: "As architect both of the Eleventh Edition and of the superstructure which now converts it into the Twelfth Edition, it has been the present writer's privilege to be served by an international company of practical builders, supplying the world's best available materials and masonry; and he has been inspired by the ambition of cementing and adorning, in the completed edifice, that great movement for Anglo-American cooperation, on whose progress from strength to strength the recovery of civilization after the World War of 1914-19 must so largely depend."

R. D. CARMICHAEL.
UNIVERSITY OF ILLINOIS

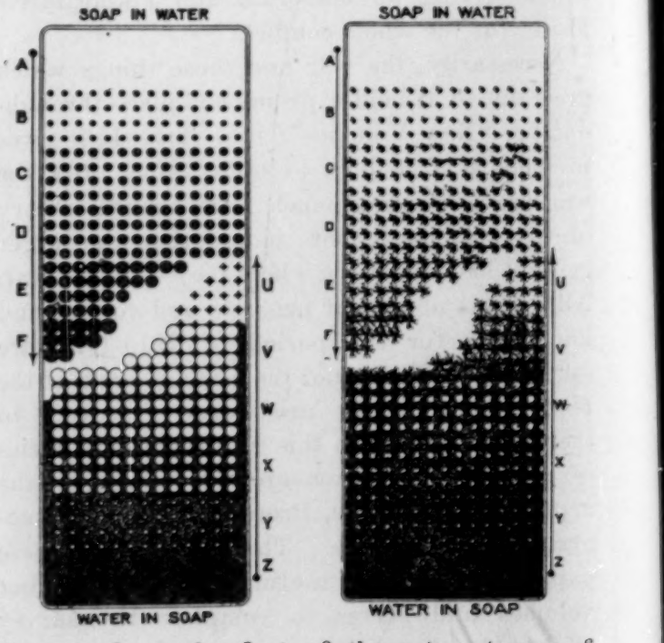
SPECIAL ARTICLES

ON THE ELECTRICAL RESISTANCE OF PHENOL WATER SYSTEMS AND OF PROTOPLASM

I

WE have tried to show in previous communications[1] that the characteristics of lyophilic colloid systems are best explained on the assumption that they are mutually soluble systems of the type phenol/water, butyric acid/water, etc.

Any lyophilic colloid system (like soap/water or protein/water) is, like phenol/water, capable of forming two types of solution, one of phenol in water and a second of water in phenol. When an ordinary soap/water system is permitted to cool, say from 100° to room temperature, it



changes from the first of these two types of solutions to the second. In the course of such change two zones of mixed systems are passed which are of special significance. As shown

[1] Martin H. Fischer and Marian O. Hooker, SCIENCE, xlviii, 143 (1918); Martin H. Fischer, SCIENCE, xlix, 615 (1919); *Chemical Engineer*, xxvii, 186 (1919); Soaps and Proteins, 64, New York, 1921.

in the diagrams of Figure 1 we pass from the original non-colloid, "molecular" or "ionized" "solution" of soap in water (zones A) through a first type of mixed system which is a dispersion of solvated soap in soaped-solvent (zones B, C, D, E) into a second which is a dispersion of soaped-solvent in solvated soap (zones V, W, X, Y). At the bottom lies the second type of true solution which we have called water in soap (zones Z). All the systems between the true solution at the top and the true solution at the bottom are, if the dimensions are correct, "colloid."

This concept explains readily the "peculiarities" of the so-called lyophilic colloid systems. Obviously it sets no limitations upon the nature of the materials that may make up such a colloid system and makes no specifications as to the nature of the forces which guarantee its stability. They are any or all which may appear or be operative whenever "solution" of any kind occurs. Electrical notions of colloid stability are at present particularly acceptable. But how can such be the dominant factors in those most typical lyophilic colloids which consist of nothing but nitrocellulose with ether and alcohol, agar-agar with water, or rubber with benzene? They are of minor significance even in those lyophilic colloid systems which are composed of an "electrolyte" and water (like soap/water). The most stabile of these systems show the least evidences of electrical charges. When such appear they are not the cause of the colloid behavior but the accidental consequence of having an overplus of "solvent" present in the system into which some of the soap has gone in true solution with secondary hydrolysis and electrolytic dissociation.

The concept of the solvated colloid as here outlined clarifies the concepts of *hysteresis, gelation capacity, swelling* and *syneresis*. Hysteresis is the expression of the fact that solution takes time, wherefore two mutually soluble substances can not quickly come to equilibrium. The point at which a lyophilic colloid "gels" is (zones F) that at which the solvated colloid phase becomes the external one. The system as a whole still carries at this point as an internal phase a solution of the colloid in the solvent. The combination marks the gelation capacity of a colloid with its solvent and is always greater than the solvation capacity of the colloid. The latter is a measure only of the solubility of the solvent in the colloid material. The increase in the volume of the latter as the solvent is taken up measures its ability to "swell." The zone Z in the diagrams covers the swelling capacity of a given material with its solvent; the gelation capacity embraces all the zones above this up to and including the zone V. As soon as this zone is passed the external solvated colloid phase may not inclose all the solution of colloid in solvent wherefore the system as a whole begins to sweat; in other words, exhibits the phenomenon known as syneresis. Colloid systems in which one of the mutually soluble materials is solid (diagram B) will obviously fail more easily to inclose adequately the internal phase than will such in which both materials are liquid (diagram A), wherefore colloids of the type sodium stearate/water, silicic acid/water, etc., show a greater liability to syneresis than more liquid ones like sodium oleate/water, rubber/benzene, etc.

II

Our various colloid-chemical studies during the past years have demonstrated the analogies which exist between the behavior of lyophilic (hydrophilic) colloids and living cells. Not only are the laws which govern *water* absorption or secretion[2] by the former identical with those which govern water absorption or secretion by living cells but the absorption and secretion of *dissolved substances*[3] is identical in both. The analogies between living matter and lyophilic colloid systems demand that the former find some place in the diagrams of Figure 1. The physico-chemical properties of protoplasm are such as place it definitely in the lower regions of the diagrams. Protoplasm is essentially, in other words, a solution of water in protoplasm. The more solid structures of the body never, normally, lie above the middle of the diagrams

[2] Martin H. Fischer, Physiology of Alimentation, 268, New York, 1907; *Am. Jour. Physiol.*, xx, 330 (1907); *Pflüger's Arch.*, cxxiv, 69 (1908); *Ibid.*, cxxv, 99 (1908); *Ibid.*, cxxvii 1 (1909); *Ibid.*, cxxvii, 46 (1909); or in connected form in Oedema and Nephritis, Third Ed., New York, 1921.

[3] Martin H. Fischer, Oedema, 202, New York, 1910; or Oedema and Nephritis, Third Ed., 206, 301, 315, 367, 393, 640, New York, 1921.

and even such liquid protoplasmic structures as blood and lymph can not lie much above the level E. The more aqueous *secretions* from the body, on the other hand, like urine and sweat, approximate the level A (that of the true solutions) though even these, through admixture with colloid substances (colloid salts and proteins) are better comparable to levels like B or C. The physical chemists have for the most part sought the solution of physiological behavior by trying to rediscover in living matter the laws of the dilute solutions. But protoplasm does not lie in or near the levels A of the diagrams but nearest the levels Z. *The physicochemical laws which govern systems of this type are those which are most likely to find unobjectionable applicability to protoplasm.*

III

The system phenol/water in its two phases, water-dissolved-in-phenol and phenol-dissolved-in-water yields in handy laboratory fashion the analogues respectively of the zones Z and A of the diagrams of Figure 1. Protoplasm is comparable to the solution of the water in the phenol; the secretions from the body to the solution of the phenol in the water. It is the purpose of this paper to discuss especially the electrical conductivity of the former.

1. Carefully purified phenol shows a very high electrical resistance (over 210,000 ohms) when measured in the customary fashion with a fixed pair of platinized platinum electrodes of the dip type (of the constant .0793) with a Wheatstone bridge arrangement and a telephone. The addition of water in increasing amount to such pure phenol progressively decreases its electrical resistance until when saturated with water (at 20° C.) it shows under laboratory conditions a resistance of not less than 21,000 ohms.

2. Our experiments were performed by adding to 50 c.c. of liquefied phenol 50 c.c. of water or the solutions to be discussed. It needs first to be pointed out that the phenol under such circumstances takes up the water and increases its volume. The phenol, in other words, "swells." When thus "swollen" through saturation with water the basal resistance of 21,000 ohms is registered. The addition of acid or alkali to the phenol/water system reduces the electrical resistance of the hydrated phenol phase. When enough of either is added the resistance of the phenol phase becomes so low as to approximate the values shown by solutions of phenol in water. At the same time that this change occurs the volume of the phenol phase also changes. Acid decreases it slightly but alkali progressively increases it. In common parlance the phenol "swells" more in the presence of an alkali than in pure water.

3. At the same normality different alkalies are unequally effective in reducing the electrical resistance of hydrated phenol, potassium hydroxide, sodium hydroxide and calcium hydroxide being progressively less effective in the order named.

4. The addition of any single neutral salt to a phenol/water system also lowers the electrical resistance of the phenol phase but not as much as do acids or alkalies. The nature of the salt employed and its concentration, however, make a difference. With progressive increase in the concentration of any single salt there is at first a decrease in electrical resistance of the phenol phase to be followed later by an increase. The volume of the hydrated phenol phase is progressively reduced with successive increments in the concentration of the added salt. When salts of a common base but with different acid radicals or salts with a common acid but with different basic radicals are compared at the same molar concentration or at the same normality, they prove unequally effective in reducing the electrical resistance of hydrated phenol. While the radicals differ even within the same group it may be stated as a general truth that monovalent radicals decrease the resistance of hydrated phenol more than divalent radicals and these more than trivalent ones.

5. Since salts show differences in reducing the electrical conductivity of hydrated phenol it is an easy matter to demonstrate an "antagonism" between them. The gradual substitution of a bivalent salt (like calcium chloride) for the sodium chloride in a sodium chloride solution therefore "antagonizes" the electrical resistance-reducing effect of the latter.

6. The addition of anhydrous ethyl alcohol to a phenol/water system at first lowers the electrical resistance of the hydrated phenol (though not as markedly as does the addition of an electrolyte) and then increases it to twice

the figure characteristic of the pure hydrated phenol. But the effect of the alcohol upon the volume of the phenol phase is a progressive one, each added amount of alcohol increasing it. When different monatomic alcohols are compared, it is found that only the lower members bring about a decrease in the electrical resistance, all the higher ones increasing it. The lower alcohols also make the phenol phase "swell" more than the upper ones.

IV

These findings are of significance for a better understanding of certain aspects of cell behavior, more particularly the phenomena of "permeability" of "cell membranes" or of "protoplasm" in general. The attempt is still being made to understand these phenomena through some modification of Pfeffer and De Vries' osmotic concept of the living cell or Overton's lipoid membrane modification of it. The physico-chemical and biological objections which may be raised against either of these notions are too numerous to need repetition here. The living cell is capable of absorbing and secreting water, of absorbing and secreting the most varied types of dissolved materials, the two moving at times in the same direction and at times in the opposite direction. There can be no adequate physico-chemical concept of the living cell which does not contain within it the possibility of understanding all these characteristics at one and the same time. The volume of the hydrated phenol phase described above "swells" and "shrinks" when subjected to the action of alkalies or of salts, shows, in other words, the biological phenomena of plasmoptysis and plasmolysis, just as does any hydrophilic colloid (protein) or the living cell. But such a phenol system shows also the "strange" phenomena of permeability to dissolved substances so characteristic of living matter. It is quickly permeable, for example, to the most varied dyes; to another group of such or to iodine it is less permeable. While permeable to the salts, hydrated phenol takes these up most slowly and in certain instances practically not at all. Identical observations are characteristic of protoplasm and the living cell.

The high electrical resistance characteristic of living matter has always been difficult to understand as long as we held to the view that protoplasm was essentially a somewhat modified dilute solution. In spite of the conclusion that a physiological salt solution is supposed to be osmotically comparable with the salts dissolved in a living animal or its body fluids, the former will register only 1/5 to 1/35 the electrical resistance of the latter. This old biological truth can be understood only by denying to the salts found in protoplasm any large existence in uncombined form or by concluding that the cell is a different sort of solvent for these salts than is water. Experimental evidence supports both these conclusions. Aside from the fact that the electrolytes are for the most part "combined" with the protoplasmic constituents and are not "free" as in an ordinary salt solution, the high electrical resistance of protoplasm is further accounted for as soon as it is remembered that protoplasm is not a solution of protoplasmic material in water but of water in protoplasmic material, one comparable in other words, to the solution of water in phenol. The effects of acids, of alkalies, of single salts, of anesthetics, etc., all of which reduce the normal electrical resistance of living matter, are then to be understood in the same terms in which these factors reduce the electrical resistance of systems of the type, hydrated phenol. Even the physiological antagonism between different salts so characteristic of living matter reappears in the case of hydrated phenol.

V

What has been said above for phenol/water systems is true of many other mutually soluble systems. Quinoline, for example, behaves much like phenol and what has been said of these substances holds also for the lower fatty acids, the soaps and the various proteins.

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THE ORIGIN OF COLUMNAR HOLES IN WANDERING DUNES

THE forests which existed on the New Jersey sand strands at Wildwood, Holly Beach, Peermont, South Atlantic City and South Seaside Park have been almost entirely destroyed, except at South Seaside Park and Peermont. The forest at the latter place has been invaded by wandering dunes, the highest of which are